Construction of an XML/RDF Schema for Description and Automated Severity Assessment of Ophthalmic Images

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ABSTRACT—We have built an Extensible Markup Language (XML) schema to describe ophthalmic images using the Resource Description Framework (RDF), an XML application for encoding and exchange of structured metadata. The schema describes the types of resources and property values allowed for a wide variety of images commonly used in clinical ophthalmology and is being used to populate an ophthalmic image database.

METHODS—The imaging schema was created with the knowledge-modeling tool Protégé (http://smi-web.stanford.edu/projects/protege), which allows domain experts to build knowledge-based systems by creating and modifying reusable ontologies. Protégé embraces the object-oriented model and defines classes as a hierarchical tree, with child classes inheriting properties from parent classes. Instances represent real-world examples of classes, and Protégé provides a tool for automatic form creation for data entry.

RESULTS—In our model, the class Patient has child classes MedicalClassification, Observations&Exam and Therapy. The class Eye Image is a subclass of Observations&Exam and is the parent class for all of the imaging modalities in ophthalmology. The primary image classes are Angio Image, Laser Image, MRI Image, Radiog Image, Ultrasound Image and VisibleLight Image. This latter category is further broken down into Mapped Image and NonMapped Image. Mapped Image includes images derived as a mapping from physical measurements, as in a spatial plot of corneal curvature or retinal light sensitivity (perimetry). Nonmapped Image represents the many types of visible light images traditionally captured on photographic film but now increasingly obtained as digital images. Image attributes were mapped by a domain expert (JJM). Automatic severity assessment based on image characteristics is performed as an aggregation of attribute values. For example, an image of the subclass PostPole Image (the posterior aspect of the eye, which is affected by diabetes) may have the attributes "any degree of vitreous hemorrhage" and "disk neovascularization greater than 1/3 disk area". Together these meet the criteria for "high risk proliferative diabetic retinopathy" justifying extensive laser treatment to treat the abnormal retinal blood vessels. Combinations of other image metadata can also summarize clinical status and can be automatically classified. By using XML and RDF, the data model is made semantic and explicit, allowing accurate and machine-readable characterization of clinical status.

CONCLUSION—We have built a draft schema for ophthalmic images and begun to instantiate an image database. The schema defines resources and properties of the most common image types. It creates a structured data model that allows for automatic severity assessment and complex querying of image metadata. We plan to further validate the XML/RDF model using other medical imaging domains to show its general applicability. A wide variety of medical domains may benefit from user-defined clinical criteria-based on image metadata to guide diagnosis and therapy.